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Case Studies on Transferring Technologies of Agribusiness-scale Production and Marketing of Asparagus and Mushrooms to Indonesia[1]

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ABSTRACT

Agriculture is the main stay and the largest sector of Indonesia's economy. Efforts have been made by the government of Indonesia to enhance food production to feed ever-increasing population in the country. Taiwan has enjoyed a high agricultural productivity through developed modern agricultural technologies in recent years. The transfer of Taiwan experienced agricultural technologies to the needy nations, becomes an important program of international technical cooperation of the ROC on Taiwan in the past 40 years.

At the request of the Indonesian government, Taiwan dispatched the Agricultural Technical Missions to Surabaya and Yogykata Provinces to help boost agricultural production in May 1976. Taiwan-assisted production of food crops and vegetables (rice, soybeans, and corn) boosted the Indonesian economy. In July 1995, Dr. Paul Min-hsien Sun, Chairman of the ROC Council of Agriculture, signed a Memorandum of Understanding (MOU) with Dr. Sjahrifudin Baharsjah, Indonesian Minister of Agriculture for a new phase of agricultural cooperation between the ROC on Taiwan and Indonesia. Taiwan agreed to transfer agribusiness-related knowledge and technology to the farmers in rural communities, and promote joint investment in the production, processing, and marketing of agricultural commodities.

Based on the MOU, the ROC Agricultural Technical Mission carried out cooperative projects on asparagus and mushroom production in Central Java Province. Mr. Kung-Chu Wu, an asparagus expert from Taiwan, organized the farmers in Boloyali County into six asparagus production and marketing teams. The farmers earned US$ 4,982/year from one

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hectare of land on which asparagus had been harvested. A marketing supervision unit has been established to help in selling asparagus since that time.

With the help of Professor Jack J. C. Hsieh of National Chung-Hsing University, the Indo Evergreen Company was established in the form of a joint venture project by a private joint Taiwanese/Indonesian investment. Mushroom-growing technology has been transferred to Indonesia from Taiwan and Belgium. Today Indo Evergreen Company produces 30 metric tones of processed mushroom everyday, of which, 95% is exported to North America and Japan, and 5 % is sold in Indonesia domestic market.

Mr. Yeh-hsuen Yu, a mushroom expert from National Taiwan University, transferred the business-scale production technology for wood ear mushroom. The project was carried out in Sleman County, Yogykata Province, and Indonesia. Mr. Yu established four ear mushroom production processes: (1) production of seed fungus growing bottles, (2) production of ear mushroom fungus inoculated plastic bags, (3) Supply of plastic bags to the growers, and (4) marketing of dried ear mushrooms through Farmer's Cooperatives. The farmers earned a net profit of US$ 186,606 from annual harvest of the wood-ear mushrooms. Plastic bag processing station earned a total of US$ 48,000/year, while seed fungus propagation station earned US$ 7,333/year. The amount of income from Marketing through Farmer's Cooperatives totaled US$ 112,000/year. The total output of the project amounted US$ 354,000/year. These are successful stories of technology transfer through international technical cooperation, jointly executed by various parties in Taiwan and Indonesia.

Introduction

Forty years have elapsed since the Republic of China on Taiwan launched the Operation Vanguard and dispatched technical missions to friendly nations in many parts of the world. The earlier efforts focused on food crops, vegetables and livestock. The first Agricultural Technical Mission (ROC-ATM) was established in the early 1960s in Africa. Starting from November 1972, all official technical assistance programs were transferred to the Committee of International Technical Cooperation (CITC), a semi-autonomous agency financed by the ROC government. The CITC was reorganized into the International Technical Cooperation and Development Fund (ICDF) in July 1996. The ICDF continues the work of international cooperation projects initiated by the CITC.

During the years since Operation Vanguard, the ICDF and its predecessors have devoted more than eleven thousand man-year of specialized assistance in overseas service missions, in six geographical regions. Mutually gratifying accomplishments have resulted from the collaborative ventures. After receiving a request for technical assistance from a

country, the ROC first send a survey team of experts to visit the country, to study possible areas for cooperation. The study mission works with officials of the host country to draft outlines of cooperating projects. An agreement or MOU for technical cooperation is then written and signed by the representative officials of the host country and the ROC on Taiwan.

In May 1976, represented by the Chamber of Commerce, Indonesia and the ROC signed an agreement on agricultural technical cooperation, which has been renewed in every two years. The first mission was sent to Surabaya in East Java in November 1976. In 1979, the second mission was sent to Yogyakata Province to help agricultural production. In July1995, Dr. Paul Ming-hsien Sun, Chairman of the ROC Council of Agriculture led a delegation of 15 experts including the writer (Hsieh 1955). The party conferred with the Indonesian Minister of Agriculture Dr. Sjahrfudin Bahasjah about the new phase of agricultural technical cooperation. The ROC on Taiwan agreed to help carrying out four rural development projects in Eastern and Central Java. Dr. Bahasjah and Dr. Sun signed the MOU in Jakarta on July 16, 1995. Based on the MOU, the ROC Agricultural Technical Mission (ROC-ATM) launched new projects of mushroom and asparagus production.

After four years of intensive work, mushroom and asparagus become an important food crop in Western Java. With the assistance of the ROC-ATM, the farmers are organized into the "Production and Marketing Teams" based on the Taiwanese model, to facilitate production and marketing of the agricultural products. Concurrently, private investors established an agribusiness scale production and processing plant. Mushroom culture and processing technologies have been transferred from Taiwan, with the assistance of professor Jack J. C. Hsieh of National Chung-Hsing University. This paper deals with the result of the technology transfer from Taiwan to Indonesia.

1. General description and agricultural situation of Indonesia

Indonesia is the world's largest archipelago, composed of more than 13,000 islands, 600 of which are inhabited. It lies along the equator for a distance of 3,200 miles. This country ranks fifth in world population, with more than 198 million people in 1995, and a population growth of 2.1% per year. About two thirds of the population lives on the islands of Java and Bali, which constitute seven percent of the nation's area. Java is one of the most densely populated areas in the world, with nearly 2,000 people per square mile. Indonesia is a centralized republic, divided into 27 provinces. Each province is divided into districts and each district comprised of sub-districts. A village is the lowest administrative unit in a sub-district.

Agriculture is the mainstay of Indonesia's economy, representing about 35 percent of the total GDP and employing approximately 63 percent of the work force. The sector has a dualistic structure. Approximately 142 million hectares are cultivated in small operations by 24 million small farmers and 22 million hectares are cultivated in large operations through 2,000

estates. Small farmers whose farm size ranging from 0.1 to 3 hectares dominate production of all subsistence and cash crops, except oil palm and tea. The most important food crops grown by small farmers are rice, corn, cassava, sweet potatoes, peanuts, and soybeans. A variety of export crops such as rubber, coffee, coconut, and fiber also produced. Livestock is usually raised with food crops and secondary crops. Poultry, beef cattle, and dairy cattle are the most commonly cultivated livestock. Fisheries are also an important agricultural commodity, with the industry dominated by small fisherman. The most important fish catches by small fishermen are shrimp, prawn, tuna and skipjack.

2. Transfer of technology for production and marketing of asparagus and other vegetables from Taiwan to Boyololi County in Central Java

(1) General situation in Boloyali County

Boyolali County is located in the southern part of Central Java Province. The county spans 40 km from east to west and 50 km from south to north, with a total land area of 10,151,010 hectares. The tropical climate consists a dry season (May~September) and a wet season (October~April) with temperatures ranging 18~32 °C. Total population of the county is 895,527 persons (1969) with a population density of 883 persons per square kilometer. The main crops include rice, tobacco, corn, soybean, peanut, cassava, sugarcane, cabbages, carrots, cucumbers, peppers, eggplants, melons and various leafy vegetables.

(2) Signing of Memorandum of Understanding (MOU) for Agricultural Technical Cooperation between Indonesia and R.O.C. on Taiwan

Dr. Paul Ming-Hsien Sun, Chairman of the ROC Council of Agriculture, and Indonesian Minister of Agriculture Sjahrifudin Baharsjah, signed MOU for agricultural cooperation in Jakarta on July 16, 1995. Based on the MOU, Taiwan agreed to help Indonesia to establish agribusiness pilot projects (Figure 1) with financing and to send experts to implement the projects which includes the following activities:

1) Transferring agribusiness related knowledge and technology to the farmers in rural community.
2) Conducting research and training and study tours to implement pilot projects.
3) Promoting joint investment in the production, processing, and marketing of agricultural commodities.
4) Developing an agribusiness support system in the rural area.

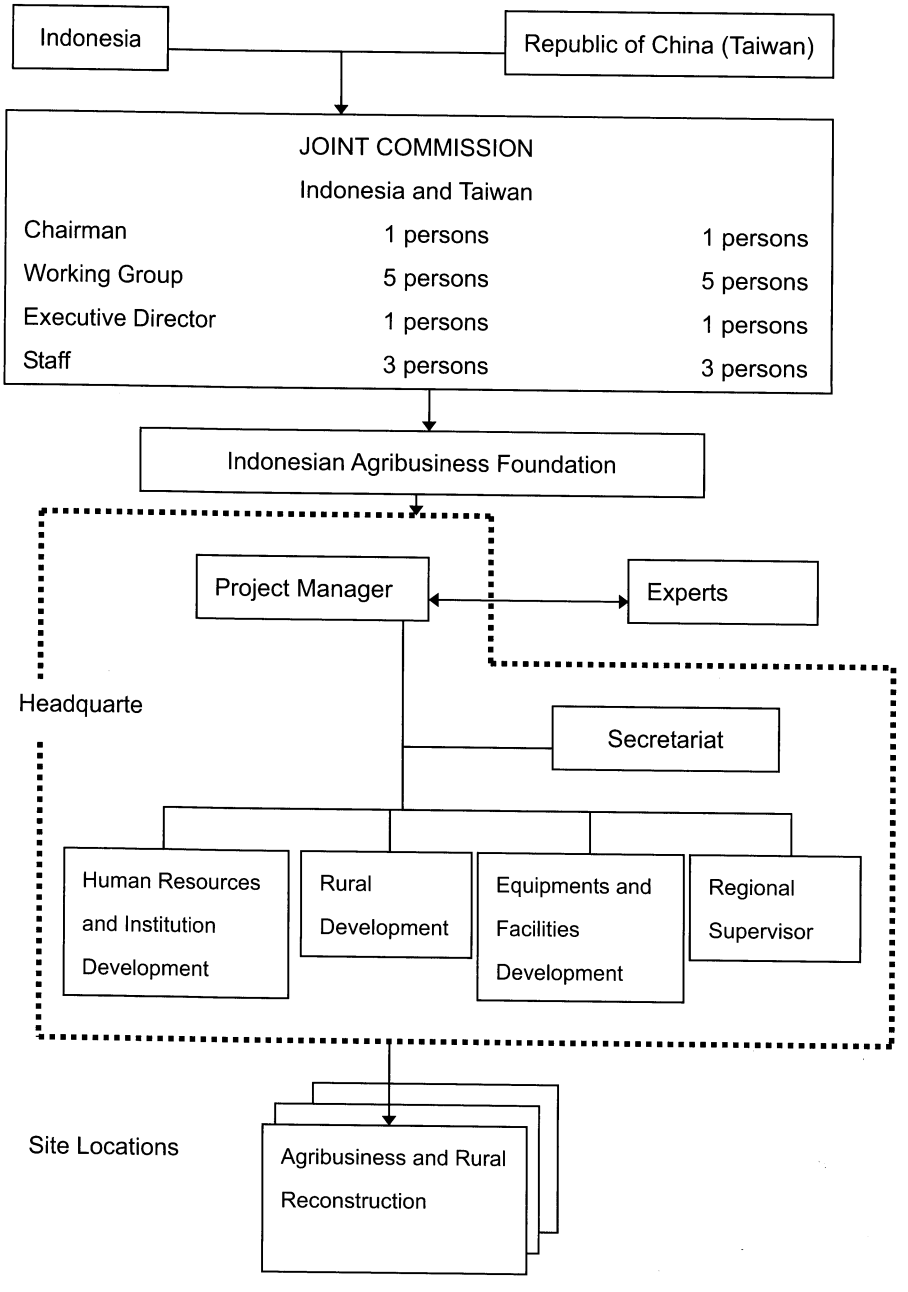


Figure 1. Frame work and structure of joint cooperation between Indonesia and ROC on Taiwan

(3) Execution of the vegetable production and marketing project

1) Establishment of demonstration farms

After signing the MOU for agricultural technical cooperation, in capacity of Executive Secretary, Committee of International Cooperation, the writer (Hsieh1995) made an on-the-spot survey to Boloyali, and worked out a detailed plan for the vegetable production project with the Boloyali officials and ROC-ATM experts. Dr. Cherng Liang Tsai, Leader of ROC-ATM, assigned Mr. Kung-Chu Wu to execute the project. Ir. Sipi Djoehadiah, Director of the Boloyali County Bureau of Agriculture, was assigned to be Dr. Tsai's counterpart. Boloyali County provided two sites (Teras and Gepogo Townships) for setting up demonstration farms. The farms are used as the bases of planting newly introduced vegetables, training and extension work. Farmers in Boloyali are hard working, and eager to learn new things. This farmer's positive attitude made the extension work easier. Initially, 3.1 hectares of land was used for the demonstration and training of vegetable culture (Table 1).

Table 1. Sites of vegetable demonstration plots

Location	Acreage (ha)	Kind of vegetables
Teras Extension Station	0.7	Asparagus, peppers cucumbers, string beans etc.
Gepogo Extension Station	0.6	Sweet peppers cherry tomatoes, peas and lettuce etc.
Simo Women's Production Team	0.2	String beans, cucumber, tomatoes, egg plants, etc.
Algemlak women's Production Team	0.2	String bean, beans cucumber, tomatoes, eggplant etc.
Andong Women's Production Team	0.2	String beans, cucumber, tomatoes etc.
Gumuksejio Women's Production Team	0.2	Asparagus, pepper, egg plant, string beans, tomatoes, cucumber
Ngemplak Women's Production Team	0.2	Cucumber, string beans, lettuce etc.
Mojosogo Women's Production Team	0.2	Asparagus, string beans, pepper, cucumber
Dlingo Farmer's Production Team	0.2	Asparagus, string beans
Singosari Farmers Production Team	0.2	String beans, Okura, cucumbers, pepper, egg plant etc.
408 Army Unit of Boyolali City	0.2	String bean, phaseolus bean, Okura, pepper and eggplants etc.
Total acreage	3.1	

Source: K. C. Wu and C. L. Tsai (1997)

2) Organization of Vegetable Production and Marketing Teams

With the initial success of the field demonstrations, Mr. Wu expanded the project to include other sites for vegetable production in Boloyali following years (1996-1997). Mr. Wu organized the farmers into Production and Marketing Teams (PMT) for the integrated farming, to reduce the production cost. At this stage, a total of 116 farmer's households were organized into six PMTs to run the 19-hectare farm (Table 2).

Table 2. Farmers' households organized into Production and Marketing Teams in Boloyali, 1996-1997

Name of Production and Marketing Teams (P.M.T.)	No. of farmers' households	Size of farm (ha)
Bangsalan PMT	29	4.39
Jembungan PMT	21	4.59
Karangdure PMT	4	2.60
Dlingo PMT	20	2.10
Jurug PMT	8	2.00
Miwis PMT	20	2.20
Mudal PMT	14	1.20
Total	116	19.08

Note: Locations:

Bangsalan Village, Teras Township
Jembungan Village, Banyadsno Township
Karangduren Village, Sawit Township
Dlingo Village Mojosongo Township
Jurug Village, Mojosongo Township
Mliwis Village, Cepogo Township.

3) Improvement of cultural system in Boloyoli

In past years, Boloyali's farmers practiced traditional rice-based agriculture, and earning very low incomes. In order to diversify the use of land, Mr. Wu conducted a series of experiments on rice-based rotational culture with other vegetables. Six rotational systems had been recommended to farmers for adoption. The farmers who adopted the new cultural system increased their income two times that of traditional system (Table 3). The newly established rotational farming systems are now widely used in Boloyali, especially by the vegetable PMTs.

Table 3. Comparison of farming income between the traditional and recommended rotational systems of farming in Boloyali County

	Rotational system			Net profit (US$/ha)	Difference (A-B)
	Jan.-Apr.	May-Aug.	Sept.-Dec.		
(A):	Rice	Musk melon	Bitter gourd	3,521.3	3,056.8
(B):	Rice	Rice	Rice	464.5	
(A):	Pepper	String beans	Musk melon	4,851.4	4,385.8
(B):	Rice	Tobacco	Rice	465.6	
(A):	Tomato	Rice	Musk melon	3,448.1	1,691.7
(B):	Rice	Tomato	Rice	1,756.4	
(A):	Cucumber	Rice	Musk melon	2,848.8	202.1
(B):	Rice	Pepper	Rice	2,646.7	
(A):	Rice	Musk melon	Pepper	4,338.5	2,182.2
(B):	Rice	Musk melon	Rice	2,156.3	
(A):	Mask	Bitter gourd	Pepper	5,703.5	3,873.9
(B):	Rice	Bitter gourd	Rice	1,829.6	

Note: (1) The exchange rates US$ 1: Rp 7,500. (2) Source: K. C. Wu and C. L. Tsai (1997).
(A): Recommended Rotational system; (B): Traditional cultural system.

4) Asparagus production and marketing project

Asparagus is a high valued cash crop in Indonesia. In order to develop the asparagus industry, some investors introduced asparagus in the Medan District of Northern Sumatra Province for plantation in 1990. In spite of enormous efforts made by the investors, for technical reasons the asparagus production was not very successful. They eventually abandoned the idea of growing asparagus in Indonesia for many years.

Taiwan is well known for growing asparagus and was once the number one asparagus exporting country in the world (1960). The prosperous asparagus production in Taiwan depended mainly on the research development at Yi-Chu Asparagus Research Center. Because of this, the Boloyali County government requested that Taiwan transfer its asparagus production experience to Indonesia. In December 1995, in response to the request, the ROC-ATM introduced Tainan Sel. No. 3 from Yi-Chu Asparagus Research Center. Mr. Kung-Chu Wu, an asparagus expert from ROC-ATM was assigned to take charge of the asparagus project in Boloyali.

Mr. Wu planted the introduced asparagus on a small plot (0.25 ha) of the Teras Demonstration Farm for trial. The initial trial was quite successful, primarily due to the adaptability of asparagus variety Tainan Sen No. 3 to the Boloyali environment. The high ridge culture with the properly timed fertilizer application, and water management, enabled the young seedlings to grow quickly. After five months of growth, asparagus is at the stage of first harvest, the upper stem of the plant is cut off, but the root remained in the soil for development of new shoots. Organic fertilizer is applied at every cutting of the stem. This ratooned method of asparagus culture, widely used in Taiwan, was found to be very useful in Indonesia as well. The price of asparagus in the supermarket was around US$ 7 to US$ 8 per kg at trial sales.

Encouraged by the promising results, Mr. Wu then organized the farmers into different PMTs, to facilitate the transfer of technology (Table 4). With free seeds, instruction and training provided by Mr. Wu, the PMT members started planting asparagus (Table 4). Asparagus acreage increased rapidly reached 38.78 ha in 1988 (Table 5).

At the initial stage, the farmers did not know how and where to sell the asparagus. Mr. Wu and local extension officers then helped farmers to sell asparagus to Jakarta via air flight as a trial. The initial market response in Jakarta was very good, which gave the farmers in Boloyali County, the confidence that even more profit could be gained from the asparagus production. Mr. Wu then strengthened his efforts to train farmers to grow the high quality asparagus (Table 4). He also provided farmers with free seeds and fertilizer. The net profit of asparagus production from 1 ha of land was US$ 3,332.8 in the first years, and US$ 4,306.4 in the second year and increased to US$ 4,982.0 in the third years and thereafter (Table 6).

Table 4. Training program organized by ROC-ATM in Boloyali County (From July 1996 to November 1997)

Time/location	Subject	Category of participants	No. of participants
1996			
Oct./Teras	Agribusiness management	County extension agents	40
Oct./Dlingo	Vegetable culture	Termus (P.M.T.)	25
Nov./Singosari	Vegetable culture	Do	40
Nov./Dlingo	Vegetable disease control	Do	25
Nov./Singosari	Do	Do	40
Nov./Teras	Agribusiness management	County extension agents	20
Dec./Teras	Asparagus nursery technique	Women's team	25
Dec./Teras	Vegetable cooking	Village women	40
Jan./Bangalan	Asparagus nursery technique	Farmer (P.M.T.)	25
Jan./Bangalan	Vegetable culture technique	Farmers (P.M.T.)	40
Jan./Boyolali	Do	408 compound	
Feb./Teras	Field practice for vegetable culture	Farmers	40
March/Mudal	Vegetable culture technique	Farmers (P.M.T.)	20
March/Teras	Post harvesting technique of asparagus	Farmers (P.M.T.)	30
March/Mliwi	Vegetable culture	Farmers (P.M.T.)	40
April/Teras	Vegetable culture	Farmers (P.M.T.)	150
April/Dligo	Vegetable culture	Farmers (P.M.T.)	150
June/Teras	Agribusiness management	Extension workers	40
1997			
July/Teras	Vegetable production practice	Agri.Voc. School students	16
July/Metuk	Asparagus culture and post harvesting treatment	Farmers (P.M.T.)	25
July/Teras	Vegetable production lecture and field practice	College students and extension worker	57
July/Teras	Agribusiness management	Agric Ext. workers	6
July/Teras	Asparagus culture and post harvesting treatment	Farmers (P.M.T.)	25
July/Teras	Vegetable production	College students	7
July/Teras	Agribusiness management	Core farmers	24
Aug./Teras	Vegetable production technique	Agric. ext. worker	42
Aug./Sawit	Asparagus culture and post harvesting treatment	Farmers (P.M.T.)	30
Aug./Teras	Agribusiness management	County extension worker	21
Aug./Manggis	Asparagus culture and post harvesting treatment	Farmer (P.M.T.)	25
Sept./Mliwis	Do	Do	20
Sept./Manggis	Do	Do	20
Sept./Teras	Agribusiness management	County extension agents	
Oct./Teras	Do	Do	40
Oct./Teras	Do	Core farmers	6
Nov./Teras	Do	Core farmers	24
Total	35 Training courses		1258

Source: K. C. Wu and C. L. Tsai (1997)

Table 5. Acreage of asparagus production as a result of extension work by Mr. Wu Kung-chu of ROC-ATM in Boloyali County, 1995-1998 (Variety: Tainan Sel. No. 3 from Taiwan)

Location (village/township)	No. of farmers household	Planted acreage (ha)	Harvested acreage (ha)
Teras/Teras	11	2.24	2.24
Bangsalan/Teras	51	6.85	2.71
Salakan/Teras	23	1.715	1.325
Mudal/Boyolali	42	6.38	6.06
Tlatar/Boyolali	7	0.95	0.95
Jembangan/Banyudono	9	1.97	0.77
Mliwis/Cepogo	2	0.50	0.50
Dlingo/Mojosongo	15	0.955	0.25
Metuk/Mojosongo	33	3.67	2.23
Jurug/Mojosongo	30	4.14	1.82
Mangis/Mojosongo	11	1.73	0.97
Tlawong/Sawit	46	3.445	2.425
Gombang/Sawit	17	2.265	1.745
Cepogo/Sawit	7	0.80	0.41
Jenengan/Sawit	5	0.32	0.32
Ngampon/Ampel	8	0.555	0
Karangangko/Kleten	1	0.30	0
Total	318	38.785	24.729

Source: K. C. Wu and C. L. Tsai (1997)

Table 6. Estimated input and output of asparagus production in Boloyali, Indonesia (Based on 1 ha of land)

Input and output	Amount (US$/ha)		
	1 st year	2 nd year	Third year
(A) Input			
Land rent	333.3	333.3	333.3
Land preparation	93.3	0	0
Labor	800.0	800.0	800.0
Seed	32.0	0	0
Fertilizer	466.7	466.7	466.7
Agric. chemicals	20.0	20.0	20.0
Other materials	18.9	9.6	182.0
Total	1,764.2	1,629.6	1,802.0
(B) Output			
Annual yield (kg)	9,600 kg	11,200 kg	12,800 kg
Selling price/kg	0.53	0.53	0.53
Total output value	5,088.0	5,936.0	6,784.0
(C) Net profit: (B)-(A)	3,332.8	4,306.4	4,982.0

(1) Exchange rate US$ 1: Rp 7,500. (2) Source: K. C. Wu and C. L. Tsai (1997).

5) Marketing of asparagus

Marketing of asparagus and other vegetables is jointly supervised by the Agricultural Bureau of the Boloyali County Government and by ROC-ATM experts. The commodities produced by the PMT are collected at village commodity collection stations. The collected commodity is cleaned, washed, and weighed. The total collected commodities from different collection stations are then transported to the county commodity collection center. The commodities are then placed into different grades according to their quality. They are then packed, and sent directly to the local supermarkets. A portion of the collection is stored in a cold storage room for export to other countries. A flow chart of the asparagus distribution system is given in Figure 2.

The amount of asparagus sold at the initial stages in April 1997 was 191 kg. This increased to 3,862 kg by the end of 1997. The amount of asparagus sold in October 1998 increased to 9,033 kg, with net profit of US$ 7,016.2, compared to US$ 102, in April 1997. Since asparagus can be harvested year round, the accumulated product from April 1997 to December 1998 was 61,677.3 kg with a net market price of US$ 40,3221. This is certainly a good profit for the farmers in Boloyali (Table 7).

If asparagus and other vegetables produced by the PMT were pooled together, the amount sold would be ever higher. For instance, the amount of vegetables sold at the six-month period from July to December 1998 totaled 53,204.2 kg, with a net profit of 280,454,575 rupiahs or US$ 37,394 (Table 8). Farmers are very happy with this remarkable result. This is an example of a successful transfer of technology from a foreign country to Indonesia.

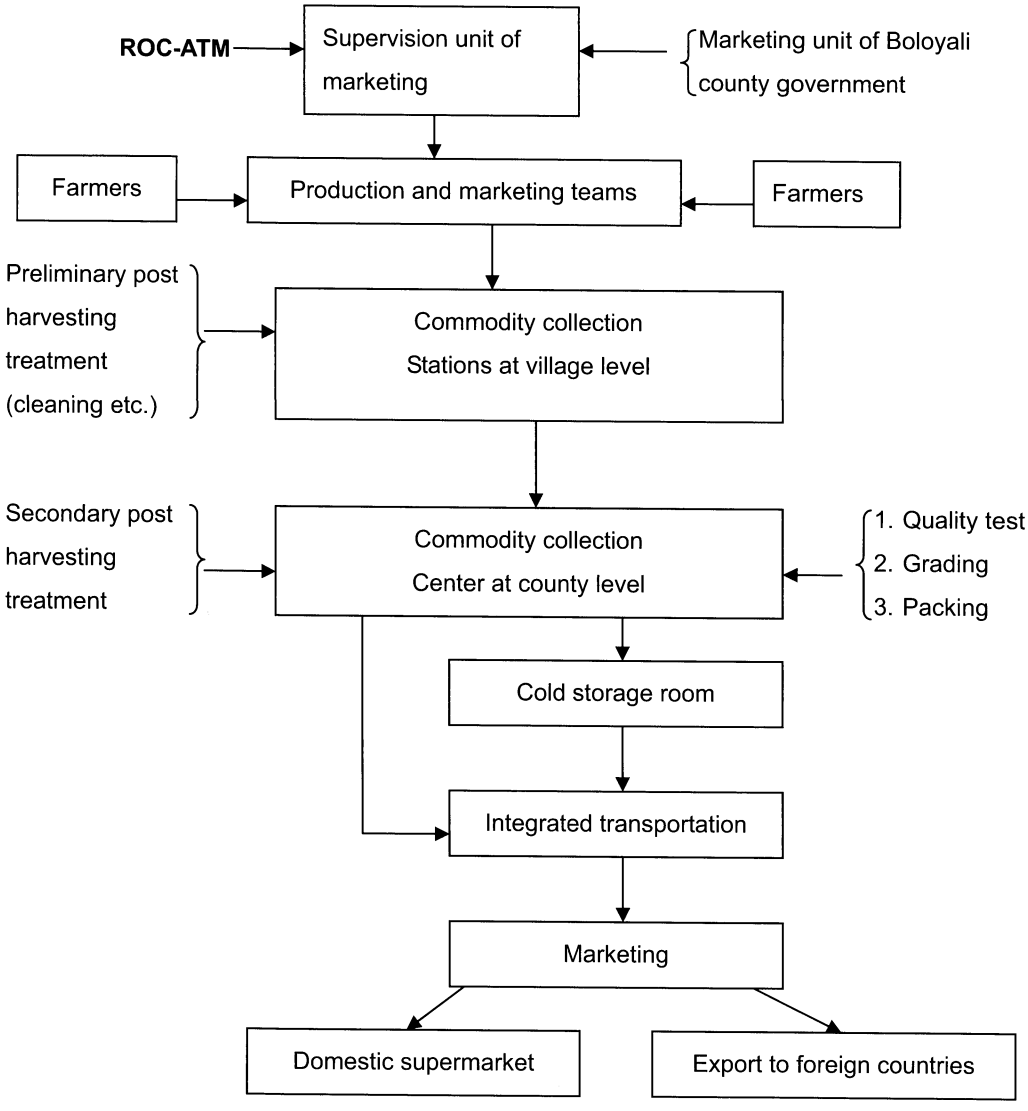


Figure 2. Flow chart of ROC-ATM cooperative asparagus and vegetable marketing in Boloyali, Indonesia.

Table 7. Marketing of asparagus in Boyolali County, April 1997-December 1998

Marketing period	Asparagus sold (kg)	Marketing Profits (US$)
04/1997	191.0	102.0
05/1997	169.0	90.1
06/1997	175.0	93.3
07/1997	512.0	273.1
08/1997	768.0	409.6
09/1997	1,008.0	537.6
10/1997	1,333.0	710.9
11/1997	2,375.0	1,266.7
12/1997	3,862.0	2,059.7
01/1998	3,727.0	1,987.7
02/1998	2,686.0	1,432.5
03/1998	2,375.0	1,266.6
04/1998	1,623.0	865.6
05/1998	2,205.0	1,149.3
06/1998	5,351.0	3,210.6
071998	4,413.5	2,208.0
08/1998	5,050.7	4,138.4
09/1998	5,681.1	4,183.8
10/1998	9,033.0	7,016.2
11/1998	5,609.3	4,488.9
12/1998	3,529.7	2,831.4
Total	61,677.3	40,322.1

Exchange rate 1US$: rupiah 7,500 Source: K. C. Wu and C. L. Tsai (1997)

Table 8. Asparagus and other vegetables sold through the marketing center at Boyolali County, July-December 1998

Marketing period	Asparagus and vegetables sold (kg)	Marketing Profit (US$)
07/1998	6,533.5	4,789.4
08/1998	7,817.3	6,323.8
09/1998	8,395.3	5,914.2
10/1998	14,786.7	9,937.9
11/1998	9,926.3	6,497.2
12/1998	5,745.1	3,930.1
Total	53,204.2	37,392.6

3. Transfer of technology for production and marketing of common white mushrooms from Taiwan to Bandung province of Indonesia

Indonesia has an environment suitable for growing many kinds of mushrooms. There are plenty of waste materials such as rice straw, baggase, sawdust etc. that can be used as the culture media for mushroom production. Additionally, production and labor costs are very low, and there is a great market for edible mushrooms in Indonesia.

(1). Development of technology for agribusiness scale production and marketing of common white mushroom (*Agaricus bispours*) in Indonesia

The Indo Evergreens Company, jointly invested in by the Taiwanese investor Yang Yung-chung and the Chinese Indonesian investor Choo Koh Guan, is producing common white mushroom with an agribusiness scale. In addition to growing mushrooms in large scale, the company runs a mushroom canning factory, with a total of 800 workers. The writer (Hsieh 1995) visited the company in Bandung in 1995 and was impressed by the scale and successful operation of the company. In this section, the observations made by the writer with regard to the operation of the company will be described.

(2). Mass production of common white mushrooms

Indo Evergreen is a joint venture cooperation between a Taiwan based company and Indonesian partners. Therefore, technologies are mainly transferred from Taiwan. With the transfer of technology and technical assistance from Taiwan, the company worked on a pilot project together with a team of consultants led by Prof. Jack J. C. Hsieh of National Chung-Hsing University in Taiwan in 1988. The objective was to determine the possibility of Champignon mushrooms being grown in the West Java on a year-round basis.

With the success of the pilot project, Indo Evergreen decided to launch a commercial scale mushrooms-growing operation, starting at the village of Sukamanah, with 8.5 hectors of land. They also constructed 300 units of mushroom growing house units. The company started the mushroom growing operation with a daily production capacity of six metric tons of fresh mushrooms.

While commercial mushrooms growing was still in development, the canning factory was constructed in the Banjaran area with 4.2 hectors of land. It is located 33 km from the plantation, a travelling distance of about 45 minutes to 1 hour by car. In late 1992, Indo Evergreen explored the possibility of expanding its mushroom growing operation with a target production of 12 metric tons of fresh mushrooms per day. With the support of the local government, the company agreed on a 20-year contract agreement with P. D. Manin to set up the second plantation site at Margakerta village. The second plantation site is about 10

minutes from the Sukamanah site plantation, occupying 35 hectors of land housed with an additional 300 units of mushroom growing house units and compost production facilities.

Both plantation sites are located in the Pangalengan area. The company has chosen Pangalengan for the mushroom growing operation because it has an altitude of 1,500 meters, with an average day time temperature of 22 to 26 ^{o}C, and an average night time temperature of 12 to 14 ^{o}C. Additionally, Pangalengan is a densely populated area.

The mushroom growing industry is both a labor- and capital-intensive industry. Because canned mushrooms are a commodity item, they are subject to the principle of supply and demand, which greatly affect the world marketplace. Because of expense of costly rice straws used in mushroom growing, Indo Evergreen decided to look for a substitute material. The substitute material found was sugar cane pulp, commonly known as "baggase". Bearing in mind that Indonesia is the only country in the world that uses "baggase" as compost for mushroom growing, and that the "baggase" has a different characteristic than that of rice straw, the company called in an experienced Belgium-based consultant firm to assist the company in further development.

Based on the technology transferred from Taiwan, two changes were made after the recommendation made by Prof. Jack J. C. Hsieh. The first was the separation of compost production facilities from the mushroom growing operations; the second was the use of 'baggase" as one of the basic compost production materials. These two changes were implemented in mid-1994. After the first six months of operation, the revised growing system began delivering convincing results. The company was then producing an average of 15 tons of fresh mushrooms per day. This method continued to show positive production results.

Indonesia is still the only country in the world that has a natural climatic condition for industrial scale year-round mushroom growing, which is an advantage over other mushroom producing countries. Indo Evergreen expansion plans to increase the fresh mushroom production capacity to 30 metric tons per day. The developmental process of Indo evergreen company is summarized in Figure 3.

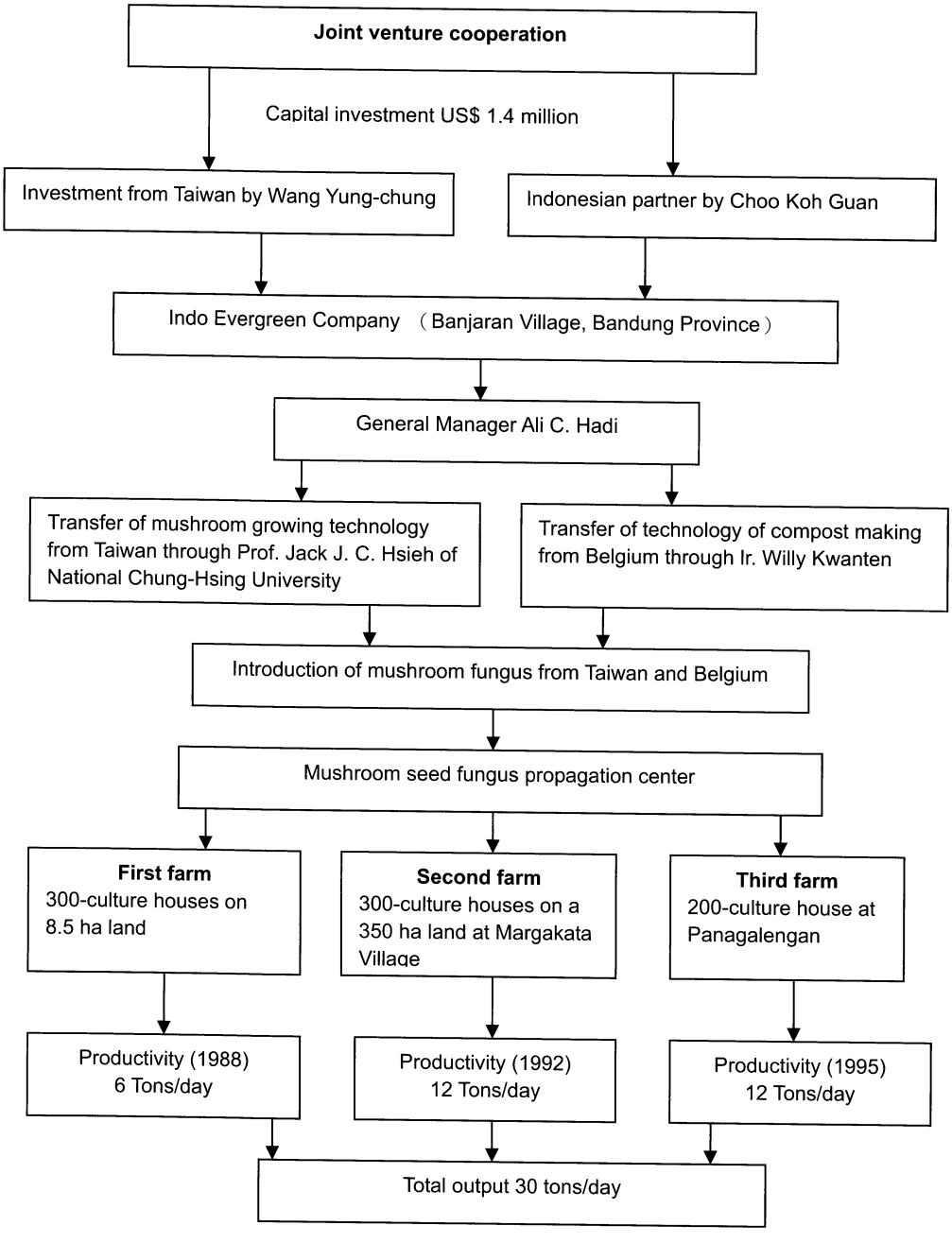

Joint venture cooperation
Capital investment US$ 1.4 million
Investment from Taiwan by Wang Yung-chung
Indonesian partner by Choo Koh Guan
Indo Evergreen Company （Banjaran Village, Bandung Province）
General Manager Ali C. Hadi
Transfer of mushroom growing technology from Taiwan through Prof. Jack J. C. Hsieh of National Chung-Hsing University
Transfer of technology of compost making from Belgium through Ir. Willy Kwanten
Introduction of mushroom fungus from Taiwan and Belgium
Mushroom seed fungus propagation center
First farm
300-culture houses on 8.5 ha land
Second farm
300-culture houses on a 350 ha land at Margakata Village
Third farm
200-culture house at Panagalengan
Productivity (1988) 6 Tons/day
Productivity (1992) 12 Tons/day
Productivity (1995) 12 Tons/day
Total output 30 tons/day

Figure 3. Development of mushroom production on an agribusiness scale in Indonesia

(3). Operation of the Indo Evergreen factory

The Indo Evergreen factory is equipped with facilities to pack both glass-jarred and canned mushrooms at approximately 30 tons per day. It is presently working on a 2-shift basis. Planned, designed, implemented and organized by the consultant team led by Prof. Jack J. C. Hsieh from Taiwan, the factory commenced its operation in September 1992, and just weeks later in November 1992, Indo Evergreen exported the first container loads to the United States.

The Indo Evergreen cannery operation is still growing, with the consistent support, sound guidance, advice, and guidance given by the processed food professionals from Taiwan, United States and Japan. The continuous support of the local government helps in maintaining and improving the infrastructure. Indo Evergreen has entered the competitive world marketplace and maintains its position as one, a producer's quality processed mushroom.

Today, Indo Evergreen exports 95 percent of its total production quantity, of which 50 percent goes to the United States, 40 percent to Japan and 5 percent to Canada, branded with popular brand names such as Green Giant, Kroger, Foodclub, Freshlike (U.S.), Blue Flag, Salad Club, Coop, and Inageya (Japan). The remaining 5 percent are distributed fresh and canned to local markets. Currently, the world's major mushroom consuming country is the U.S., with a reported total 68,500 tons of imported processed mushrooms in 1994. About 45 percent of the imports come from Mainland China, 20 % from Indonesia, 7 percent from Chile, 3 percent from Mexico, and the remaining 25 % from various countries throughout the world.

It is believed that agribusiness prospects in Indonesia will continue to show positive, and with continued supports, Indo Evergreen has the potential to gain market share in the future. With a favorable climate, the transfer of technology and technical support, there are still many agricultural and horticultural products the company believes can be grown and packed in Indonesia, with high export potential. The operation of Indo Evergreen mushroom processing and marketing is summarized in Fig. 4.

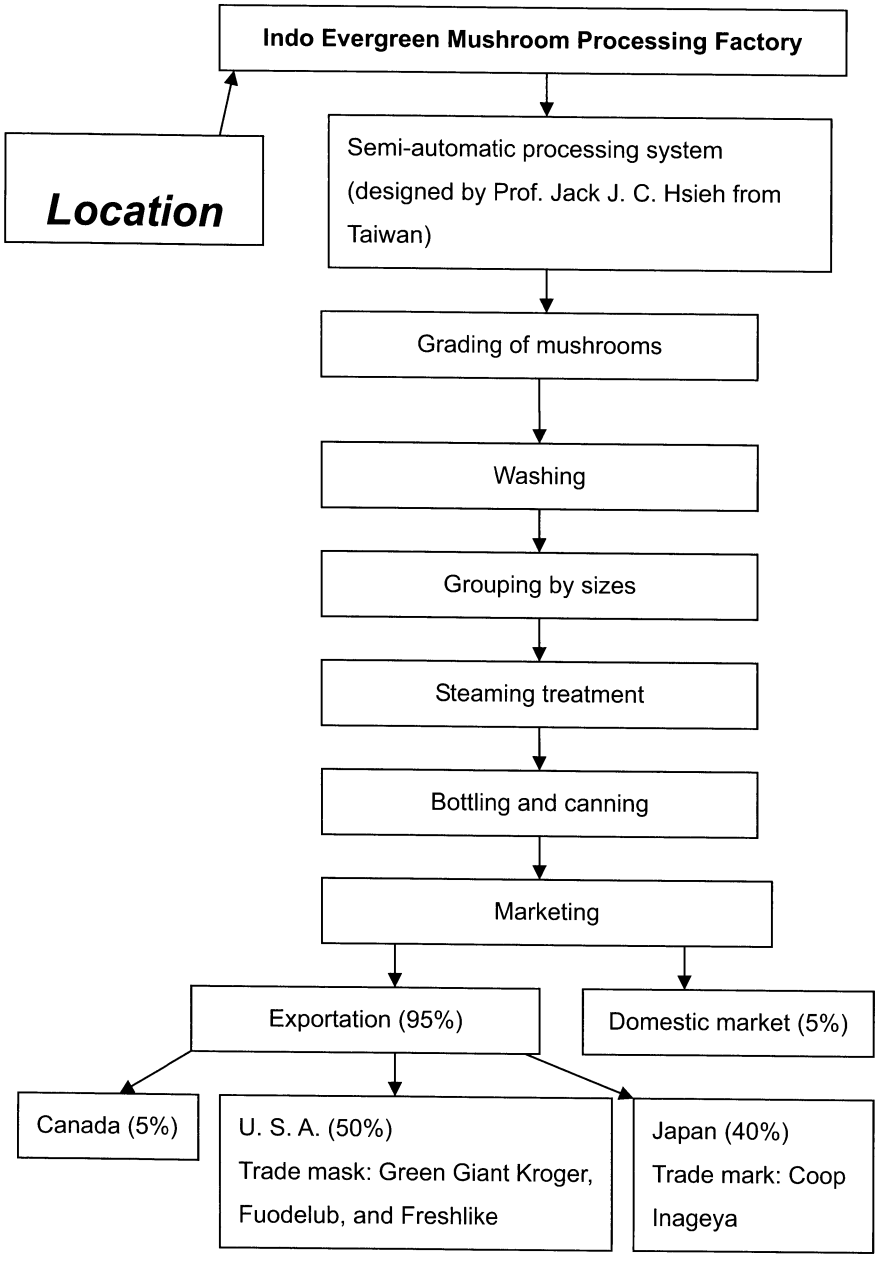


Figure 4. Operation of mushroom processing and marketing of Indo Evergreen Company in Indonesia.

4. Transfer of wood-ear mushroom culture technology from Taiwan to Yogyakata province of Indonesia

Encouraged by the successful experience of the Indo Evergreen Company, the government of Indonesia wishes to develop the technology of culturing other kinds of mushrooms for extension to other districts. Based on Article 1 of the MOU signed in 1995, the ROC on Taiwan agreed to help farmers in Yogyakata province develop mushroom production industry. Mr. Yeh-hsuen Yu, a mushroom expert from the ROC-ATM was assigned to station at Sleman County of Yogyakata Province to carry out the proposed project. With financial support from the ROC-ATM, Mr. Yu set up a training center at Ngipiksari in Sleman. The Center has a laboratory with equipment, mushroom culture houses, and other facilities.

Mr. Yu introduced various kinds of mushrooms from Taiwan and other sources such as common white mushroom (*Agaricus bisporus*), wood-ear or ear mushroom (*Auricularia avaicula*, Hook), abalone mushroom (*Pleurotus ostreatus*), shitaka (*Lentinula edodes*), and ling-zhi (*Ganoderma lucidum*). He was able to culture all of the mushrooms, using the plastic bag method. The plastic bags are 40 cm in length, 13 cm in width, 0.6 cm in thick. They are filled with culture medium, which consists primarily of sawdust and other nutrients such as rice bran. The filled plastic bags are then sterilized under high temperature (98-100^{o}C) for 5-8 hours. After cooling, the mycelia of wood ear fungus are inoculated on the top of the culture medium, and then the opening part of the bag is tied. The inoculated plastic bags are then placed in a culture room at a temperature of about 20-24^{o}C and at 70% relative humidity. After the mycelia are fully-grown inside the plastic bags, the tightened parts of the bags are then cut off to allow the fruiting body to come out gradually. After the fruiting body is grown up to a proper size, it can be harvested. The harvested wood-ear mushrooms can either be sold in fresh or dried for selling at a later date.

(1). Extension of wood-ear mushroom

After the successful development of culture technology of wood-ear mushrooms, Mr. Yu organized nine mushroom production-training courses for the local farmers in Sleman County. A total of 482 farmers participated in the courses. One hundred and fifty-two people attended three additional courses from other regions including college professors, extension officers, and farmers. The participants received training on various subjects including microscopic identification of fungus strains, isolation and culture of the selected fungus strains from the impure fungi, methods of preparing culture media; method of preparing plastic bags, management of mushroom culturing houses, harvesting and drying wood ear mushrooms.

In addition to the classroom lectures, the participants were asked to perform each step of the culture in order to get hands-on experience. With this training, they could independently operate their own farms after they returned to their homes. The farmers received instructions from Mr. Yu from time to time taking advantage of his frequent visits to each farm. Because of its relatively easy practice and high profit, wood ear mushroom culture has spread quickly in Sleman County.

(2). Extension Sites

The following townships were selected as the primary sites for wood ear mushroom extension: (1) Gambretan, (2) Cangkringan, (3) Turi, (4) Kalizrang, and (5) Kepoharjo. The five townships are located at 700-1,000 m above sea level with temperatures ranging from 17 ^{o}C to 29 ^{o}C. This environment is especially suitable for growing wood-ear mushroom year-round. There was also another reason for choosing these townships. These towns are situated on the mountain slope land, which is not suitable to grow crops due to its poor soil condition and lack of water supply. Job opportunity in this area was scarce, and was rated to be the poorest mountain villages in Yogyakarta Province. This region was chosen with the hope, that the living standard of the inhabitants there could be improved after growing wood-ear mushroom.

(3). Organization of Production and Marketing Teams for Wood-Ear mushrooms

Production and Marketing Teams (PMTs) have been proven to be the most efficient way to promote crop production in Boloyali. Similar systems can also be established in wood-ear mushroom production. Up to 1999, Mr. Yu organized a total of 12 PMTs in Sleman County. Each team consisted of 40-50 farmers. Each farmer constructed 1-4 mushroom culture houses and a total of 980 cultural houses were constructed. A team leader was elected for each team. The team leaders made plans for production and solved technical problems with help from Mr. Yu and county extension officers.

(4). Process of Extension Work

First stage (Demonstration stage):

The ROC-ATM 100 percent subsidized the cost of constructing four mushroom culture houses for selected farmers, to serve as demonstration farms. The wood-ear mushroom mycelia inoculated plastic bags were given to the farmers by the ROC-ATM free of charge. The well-trained farmers took care of the wood-ear mushroom houses with productive results. The harvested wood-ear mushrooms were directly sent to the supermarket with the help of Mr. Yu and earned high profits. The profits from the sale of wood-ear mushroom produced from one cultural house (78 m^2) were equivalent to the profits of rice harvest from one hectare of rice field per year. Because of this high profit, the neighboring farmers quickly joined the team to grow wood ear mushroom.

Second stage:

Eight mushroom culture houses were constructed with subsidies 50 percent from the ROC-ATM, but no subsidies were given to buy the mycelia inoculated plastic bags. The farmers had to buy the plastic bag from the ROC-ATM.

Third stage:

No subsidies from the ROC-ATM were provided. Farmers paid all expenses for the 623 mushroom culture houses and the plastic bags.

(5). Process of wood-ear mushroom culture and marketing

Preparation of seed fungus mycelia

The ROC-ATM is responsible for propagating the pure seed strain of the selected stock fungus (F1) at the Ngipiksari Training Center. The stock fungus strain is supplied to the Seed Fungus Propagation Center. The Center multiplies the stock strain into secondary (F2) and tertially strain (F3) in glass bottles (or plastic bottles). These bottles, which contain the seed mycelia of ear mushroom, are then sold to the plastic bag producers as the inoculums, at the price of 1,000-1,500 rupiahs per bottle.

Production of wood ear mushroom fungus inoculated plastic bags

Under Mr.Yu's supervision, the plastic bags that contain wood ear mushroom fungus inoculated culture medium are produced. The rate of contamination is controlled at less than 5 percent.

Supply of plastic bags to the growers

Farmers buy the plastic bags at a price of 500 rupiahs or US$ 0.067 per bag from the supplier, and place them in their own culture houses. After the profuse growth of mycelia in the bags, the fruiting bodies come out. The fruiting bodies are then increased in size to be harvested. The harvested wood-ear mushrooms are then dried and stored.

Marketing of the dried wood-ear mushroom through Farmer's Cooperatives and Trade Companies

The dried wood-ear mushrooms are then packed and separated into different grades, 6 kg per package. The Farmer's Cooperatives buy the packed wood ear mushroom at different prices, according to the different grades. The trading company buys the dried wood-ear mushrooms at a price of 21,000 rupiahs per kilogram (US$ 2.8/kg) for the first grader; 20,000 rupiahs per kilogram (US$ 2.6/kg) for the second grade; and 18,000 rupiahs per kilogram (US$ 2.4/kg) for the third grade. Each of the four steps earns a reasonable profit; therefore everybody is satisfied with this production and marketing scheme.

(6). Economic analysis of wood ear mushroom production in Indonesia

The plastic bags that contain culture medium and the inoculated fungus are the primary force behind wood-ear mushroom production. The used plastic bags should be replaced with new ones after each round of production. Production of plastic bags requires special technology and certain facilities; therefore experienced experts and dealers usually handle this task. It is not difficult for farmers to buy the plastic bags from a plastic bag-processing center. According to Mr. Yu (1999), the cost of plastic bag per package is 309.88 rupiahs (US$ 0.041). One package of plastic bag is sold to the farmers at a price of 500 rupiahs (US$ 0.067). The plastic bag-production center earns 190.12 rupiahs or US$ 0.025 per bags (Table 9).

Table 9. Cost of plastic bags containing culture media and wood-ear mushroom seed fungus

Material	Cost per bag (Rp)	Percentage (%)
Sawdust	42.00	13.60
Plastic bag	44.00	14.20
Rice bran	45.45	14.70
Plastic cap	40.00	12.90
Fuel	24.54	7.91
Calcium carbonate	0.45	0.15
Cotton	5.00	1.60
Labor	65.40	21.10
Seed fungus	18.50	5.97
Chemicals for sterilization	4.54	1.50
Others	20.00	6.45
Total	309.88 (US$ 0.041)	100.00

Exchange rate: US$ 1: Rp 7,500

Source: Y. H. Yu and S. L. Lee (1999).

The total cost for the running one cultural house is US$410. This includes compensation for use of the culture house, cost of plastic bags, labor costs and other related expenses. A total of 300 kg of dried wood-ear mushrooms are produced from 5,000 plastic bags in one round of culture in one culture house. The gross income per house from sales of the product is US$ 800 per cultural house. The net income from one cultural house is US$ 390. Since wood-ear mushrooms can be cultured twice a year, a net income per cultural house per year is US$ 780 (Table 10).

Table 10. Cost and net profit return from culturing wood-ear mushroom in culture houses of $78m^2$ (6 m x 13 m holding 5,000 plastic bags)

A. Gross income:	
Ear mushroom yield per house per cycle: 5,000 bags x 0.06 kg	= 300 kg
Gross income per culture house: 300 kg x $ 2.67	= $ 800
B. Expenditure (cost):	
Compensation cost for 10 culture cycles in 5 years	= $ 20.00
Cost of buying fungus inoculated plastic bags: 5,000 bags x $0.066	= $ 330.00
Labor costs for harvesting etc.: 50 worker x $0.93	= $ 46.67
Others	= $ 13.33
Total cost per culture house	= $ 410.00
C. Net income per house per culture cycle : $800 – $410	= $ 390.00
D. Net income per house per year (2 culture cycles):	= $ 780.00

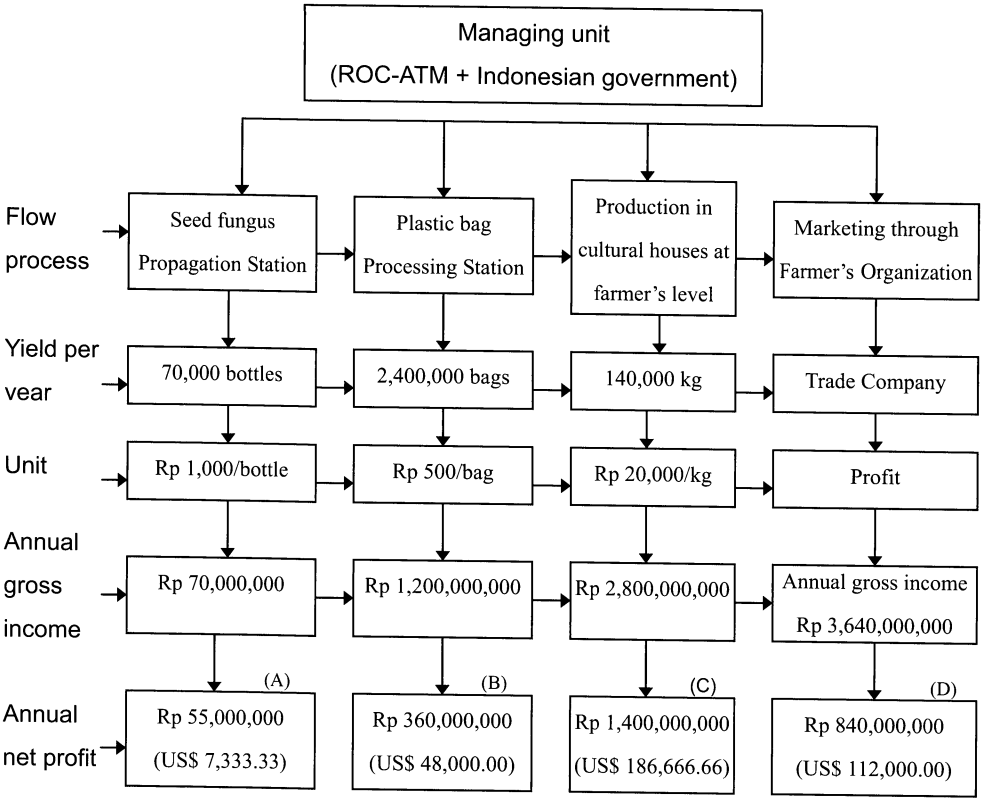
Source: Yu Y. H. and S. L. Lee 1999.

The wood-ear mushroom production and marketing flow chart with regard to the cost and return of each process was summarized in Table 11. As indicated in Table 11, four operational units are involved in production and marketing: (1) seed fungus propagation farm, (2) plastic bag processing farm, (3) production at the cultural house, and (4) the marketing unit of farmers' organization. The seed fungus stations produced a total of 70,000 bottles of seed fungus. The stations gained a net profit of US$ 7,333.33 (55,000,000 rupiahs) from the sale of seed fungus containing bottles to the plastic bag processing station each year. Using this seed fungus, the plastic bag processing station processed a total of 2,400,000 plastic bags containing inoculated mycelia. They were sold to farmers at a price of 500 rupiahs per bag and earned US$ 48,000 (360,000,000 rupiahs) net profit per year. The wood ear mushrooms produced by the farmers each year amounts to 140,000 kg, which was sold at a price of 20,000 rupiahs (US$ 2.66) per kilogram, with a net profit of US$ 186,666.66 (Rp 1,400,000,000 rupiahs). The produced wood ear mushrooms were collected by the farmers' organization and sold through the trade companies. The company sold at a profit of 25-35 percent and earned a total net profit of US$ 112,000,000 (840,000,000 rupiahs). The total net profit of above mentioned four units' amounts to US$ 354,000 (2,655,000,000 rupiahs). This is a huge sum of money for the farmers living on the remote mountains in Sleman County. More importantly, this project offered 2,500 job opportunities for the poor people in the area.

As mentioned in the previous paragraphs, any farmer who has a wood ear mushroom culture house of 78 square meters in size has the potential to gain a profit of US$ 780. This is equivalent to the profit gained from the rice production from one hectare of land per year. The plastic bag processing station is currently operated by the ROC-ATM. The total net income from the operations of this station totaled at US$ 4,441.92 (333,141,374 rupiahs) in

December of 1998. The money was deposited into a revolving fund, which in return is used to subsidize the businesses training expenses. The revolving fund was also used to invest in another plastic-bag processing station with a capacity of 120,000 plastic bags per year at Gondarg Township, in the Mojokerto County of East Java Province. This project will be operated as a joint venture with a local church foundation, to improve living standards of the people in that region.

Table 11. Cost and profit returns of each of the four units in charge of production and marketing of edible mushrooms, jointly managed by the ROC-ATM and the Indonesian government



Notes:

(1) (A) + (B) + (C) + (D) 2,655,000,000 Rupiahs (US$ 354,000.00)
(2) Exchange rate US$ 1: 7,500 Rupiahs
(3) Labor cost 200,000 Rupiahs/month/person
(4) Total employment under this project: 2500 person
(5) Source: Y. H. Yu and S. L. Lee (1999)

(7). Improvement of farmers' living standards after the implementation of the wood-ear mushroom production project

The farmers who participated in the project of wood-ear mushroom production increased their income within a short period of time. The farmers were able to buy their own new houses, new bicycles, and new furniture. The living conditions improved greatly. Two examples are illustrated in the followings:

1). Mr. Wagiman lives in Gambreton village. He used to work at the ROC-ATM as a temporary laborer with a monthly wage of 180,000 Rupiahs (US$ 24). He left the ROC-ATM and joined the wood-ear mushroom production project by establishing his own small-scale plastic bag processing station, which produces 1,400 bags a day. He started with 2 mushroom culture houses, which grew to 11 houses. The monthly net profit from the sale of plastic bags amounts to 9,000,000 Rupiahs or US$ 1,200, which is 50 times more than the wages he earned, previously from the ROC-ATM. Mr. Wagiman's annual income is now around US$ 14,400. Recently he was able to build a modern house with new furniture and buy an automobile. He is appreciates the wood ear mushroom culture project, headed by Mr. Yu.

2). Mr. Tarman, 34, lives in Kaliurang village. He used to be a bus driver with a monthly salary of 300,000 Rupiahs (US$ 40). Seven years ago he wanted to get married, however, because he lacked savings, he was unable to. He decided to earn more money through other means, so he participated in the mushroom production training courses organized by Mr. Yu in 1997. After participating in training, he built 2 mushroom culture houses under the support of Mr. Yu. He earned 11,000,000 Rupiahs (US$ 1,466.66) from the sale of wood ear mushrooms within a short period of time. With this money, he married within the next year (May 1998). He and his wife now have a young son and people in the town called his wife "Istri Jamur Kuping", which translates as "Mrs. Wood-ear mushroom". In addition to wood-ear mushroom production, Mr. Tarman is now operating a seed fungus (Auricularia auricula, Hook) propagation station, which requires more advanced technologies. With Mr. Yu's guidance, Tarman's station is now producing "seed fungus bottles" to be sold to the lower stream plastic bag processing stations. The monthly profits from the sale of seed fungus bottles from the station are 6,500,000 Rupiahs (US$ 866.66) and annual earnings are approximately 78,000,000 Rupiahs (US$ 10,399.99). This is a great deal of money for a farmer in Indonesia.

Conclusion

Agriculture is the mainstay and the largest sector in Indonesia's economy. It represents about 35 percent of total GDP and employs around 63 percent of the work force. Rural development has been the primary task of the government in Indonesia. Agricultural extension work is important in the development of agriculture in the rural areas.

Three successful cases of transfer of agricultural technology from Taiwan to Indonesia were discussed in this paper. The first case concerned the transfer of technology for the establishment of a production and marketing team for asparagus production in Boloyali County in Central-Java Province. Two locations (Teras and Cepogo Townships) were selected to set up two respective demonstration sites. Various kinds of vegetables, including asparagus, were introduced from Taiwan for trials. An asparagus expert, Mr. Kung-chu Wu from the ROC-ATM, was assigned to lead the asparagus project. Mr. Wu organized 116 farmer's households into six production and marketing teams and trained them with various technologies. A total of 1,258 farmers participated in 35 courses organized by Mr. Wu. The farmers were able to grow the newly introduced cash crop (asparagus) and gain a profit of from US$ 3,332.8 per ha of land in the first year to US$ 4,306.4 in the second year. The farmers earned US$ 4,982.0 in the third year. With the joint effort the ROC experts and Indonesian officials, a unit supervising the marketing of asparagus and other vegetables for Boloyali County was established to help with the smooth transfer of produced commodity to local market as well as foreign markets.

The second case of technology transfer was the agribusiness scale production and marketing of common white mushrooms in Indonesia by the Indo Evergreen Company. Mushroom-growing technology was transferred from Taiwan, while large-scale composting technology was transferred from Belgium. Because its success, the Indo Evergreen Company is able to produce 30 metric tons of processed mushrooms everyday. Ninety-five percent of the product is exported to North America and Japan and the remaining 5 percent are sold in Indonesia. The Company created 800 job opportunities for the local people. This is a very successful case of agricultural technology transfer from Taiwan to a Southeast Asian country.

The third case studied in this paper is the transfer of wood-ear mushroom culture technology from Taiwan to farmers in Sleman County, Yogyakata Province. Mr. Yeh-Hsuen Yu, a mushroom expert from Taiwan was sent to Ngipiksari Township, Sleman County. He was able to develop many kinds of mushroom-culturing technologies introduced from Taiwan. Among these, wood-ear mushrooms were chosen as the primary commodity for extension in Sleman County. Four sites (Gambretan, Cangkringan, Turi, Kaliurang, and Kepoharjo) in Sleman County were selected as locations for the development of wood ear mushroom

industry. A total of 12 teams were organized for the integrated production and marketing of wood ear mushrooms. A total of 40 mushroom culturing houses were constructed with the help of Mr. Yu. The extension work for wood ear mushroom production was carried out in 3 stages. During the first stage the ROC-ATM subsidized the entire cost for the construction of four culture houses. In the second stage, 50 percent of the cost of constructing eight culture houses was subsidized. In the third stage, no subsidies were provided to the farmers for the construction of 623 culture houses. Four processes are involved in wood ear mushroom production and marketing: (1) production of seed fungus growing bottles by the ROC-ATM, (2) production of wood ear mushroom fungus inoculated plastic bags, (3) supply of plastic bags to the growers, and (4) marketing of the dried wood ear mushrooms through Farmers' Cooperatives. The seed fungus stations at a value of US$ 7,333 produce a total of 70,000 bottles of seed fungus annually. The plastic bag processing stations produced a total of 2,400,000 plastic bags containing the inoculated mycelia. The net profit from the sale of the bags totals US$ 48,000 annually. The farmers earned a net profit of US$ 186,666 from annual wood-ear mushroom harvest. The marketing companies earn a total of US$ 112,000,000 from selling the product. The combined profits of the above four units amount to US$ 354,000 per annum. Because of the high profits, the farmers' living standards have been greatly improved.

Indonesia has a very good natural environment for growing various kinds of edible mushrooms, including wood-ear mushrooms. Wood-ear mushrooms are easy to grow and the market demand for this commodity is high in Indonesia. Therefore there is great potential for developing the mushroom industry. In general, the cost of processing plastic bags, which are filled with the wood-ear mushroom culture medium, occupies 80 percent of the production cost. Currently, the cost of preparing one plastic bag in Indonesia is only US$ 0.041, which are only one third of that in Mainland China, and one sixth of the cost in Taiwan. The Indonesian industry is very competitive with the principal wood-ear mushroom exporting countries, including China and Taiwan. The ROC-ATM's plastic processing station produced 120,000 bags per month in 1998. However, the amount was far less than what was needed. In view of this, Mr. Yu is now in the process of guiding potential investors in the establishment of nine more similar plastic bag-processing stations. Farmers and dealers in each step of production and marketing earned a pooled net profit of US$ 354,000 each year. This is truly a success story.

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